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EVALUATION OF COPPERAS CONTAMINATION
AT THE
AMERICAN CYANAMID COMPANY PLANT SITE
PINEY RIVER, VIRGINIA

May 1972

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EXHIBIT 1

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SUMMARY

Four test wells were installed in the vicinity of the copperas pile in the unconsolidated sediments consisting of predominately clayey material. Only two penetrated the saturated section of these sediments. Based on pumping test data, the water transmitting capacity of the sediments is very low.

The two wells in the saturated section appear to be located on either side of the original stream channel. The pH values of water samples obtained from these wells show that copperas effluent has permeated the sediments. There is a slight freshening of the sample from the well further away from the stockpile.

The physical setting of the copperas has created an artificial ground-water regimen. The source of the contamination is from precipitation falling directly on the copperas pile. At least two methods can be used to reduce or eliminate the source of effluent. Consolidation and covering the pile at the present site should be considered. However, it is felt that the relocation of the copperas to the large tailings pond is a better alternative.

After the source of contamination has been eliminated, it will take some time for the sediments to be flushed of the effluent. If the copperas is relocated to the recommended site, small diameter wells should be installed to define the rate of movement of the effluent through the sediments.

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CONCLUSIONS AND RECOMMENDATIONS

1. The source of contamination is from precipitation falling directly on the copperas pile. This could be eliminated by the consolidation of the pile and covering at the present site or preferably by the relocation of the copperas to the tailings pond south of the quarry.

2. The physical location and properties of the copperas has created an artificial ground-water siutation. Even after the source of contamination has been eliminated, the drainage of effluent from the sediments will require a considerable amount of time.

3. The estimated volume of effluent presently in the sediments is 2.6 million gallons. Assuming that the source of the effluent is eliminated, it is estimated that the total time required to drain the sediments is approximately 14 years.

4. If the copperas pile is relocated, a large segment of the saturated sediments will be removed. After the removal operation has been completed, at least six small diameter wells should be installed to obtain a refinement on rate of movement and time required to flush the sediments.

5. Even after the copperas has been removed, the effluent draining into the river may be of sufficient volume to affect the pH level of the stream. In an effort to maintain the pH level, a

limestone solution can be fed into the stream. In addition, limestone can be seeded in selected areas and surface-water bodies on the plant site.

6. If the copperas is relocated to the recommended site, then consideration should be given to the relocation of all acid sludge solids presently stockpiled on the plant property.

7. Because of the nature of the sediments, there appears to be no practical or economically feasible way to hasten the removal of the effluent.

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EVALUATION OF COPPERAS CONTAMINATION
AT THE
AMERICAN CYANAMID COMPANY PLANT SITE
PINEY RIVER, VIRGINIA

As recommended in our initial letter report of November 19, 1971, with regard to the contamination study at the American Cyanamid Company's plant site at Piney River, Virginia, a test drilling program was initiated. During the period of March 1 through March 8, 1972, Geraghty & Miller, Inc. personnel attempted to further define and evaluate the contamination from the copperas pile. No attempt was made to evaluate other possible sources of contamination.

The copperas pile lies in a very small valley which drains into the Piney River. The precipitation which falls on the pile and on the nearby surrounding land-surface eventually reaches the river as surface runoff as well as ground water. The magnitude of the ground-water flow in this valley is of primary importance in defining the volume and time element involved before these sediments are flushed, assuming the source of the contaminant is eliminated.

During this latter period of field investigation, test wells were installed in the vicinity of the copperas pile to define the subsurface geologic and hydrologic properties of the natural sediments. Figure 1 is a map of the plant site showing key features and the locations of the test wells.

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Four test wells were installed by the Falwell Well Corp. of Lynchburg, Virginia, using the cable tool method of drilling. Three wells were located at the toe of the south slope of the pile, and the fourth was located on the west side of the pile about the mid-point of the dump area.

Eight-inch diameter borings were drilled through the overburden and weathered rock until competent rock was encountered. The construction diagrams of the test wells including the geologic logs and depths are given in Figures 2 through 5. Four-inch diameter PVC pipe and screen were set in the eight-inch diameter borehole, and the annular space between the outside of the casing and the face of the borehole was backfilled with gravel and above the gravel, clay. This method of construction was selected to inhibit surface water from entering around the well casing while allowing natural ground-water to flow into the screen.

Test Wells 1, 2, and 3 were drilled to an approximate depth of 14 feet through a predominantly clayey zone. Below this material, weathered bedrock was encountered. This weathered section was less than one foot thick before contact with the competent rock. The bedrock found at these sites is white aplite, a hard, crystalline, igneous rock.

Test Well 4 was drilled to a total depth of 35.6 feet below land surface. The unconsolidated material penetrated was predominantly clay. Weathered bedrock less than one foot in thickness was found before competent rock was encountered. The bedrock at this site is a dense, black, crystalline rock.

Test Well 1 has been reportedly dry since shortly after installation was completed. However, a water sample collected March 2, after the well was installed had a pH of 3.8. At that time, less than one half foot of water was in the bottom of the well. The source of the water is thought to be residual wash water from the drilling operation. Once this water was bailed out of the well, it remained dry up to this point even after periods of recorded precipitation.

The pH value of 3.8 is significant, and will be discussed briefly at this time. The water used for the drilling operation was brought to the site in a tank from a city source. The pH, although not measured, probably can be expected to be in the range of 6 to 7. Several possibilities exist as to the cause of the low pH value of the sample. The method of drilling could have carried any copperas sediments from land surface to some depth as drilling progressed. However, the volume of water used to bail the cuttings during the drilling should have significantly reduced the effect of any small amounts of copperas that may have been carried down. The more likely assumption is that leached copperas runoff from the pile during periods of precipitation infiltrates the natural soil. Although percolation rates are very low, over the years a significant accumulation of the salts could have taken place in these sediments.

Test Wells 2 and 3 were located at the existing earth dam presently used to retain the surface flow from the copperas pile. After the wells were installed, a short-term pumping test was conducted to determine some hydrologic properties of the sediments.

Test Well 2 was pumped for 40 minutes at a rate of two gpm (gallons per minute). Based on the data, the saturated sediments appear to have a very low transmitting capability, on the order of 300 gpd/ft (gallons per day per foot). The estimated field permeability is about 60 gpd/ft^2 (gallons per day per square foot). The porosity on the other hand, is thought to be quite high. No attempt to define this parameter was made because of the nature of the sediments and copperas. That is, the high solubility of the copperas, and the ratio of copperas to sediment in this area is unknown.

Test Well 3 was pumped at a rate of four gpm for a short time. The recovery of the water levels after cessation of pumping was used to derive some hydrologic properties of the saturated sediments. The transmissivity is on the order of 200 gpd/ft. The field permeability is estimated to be 25 gpd/ft^2.

Test Well 4 has been dry since installation, since the well was not drilled deep enough to reach the saturated section. The water table is undoubtedly in the competent rock at a much lower elevation.

After the wells were installed, a monitoring program was established. The data collected consisted of: water-level measurements

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in the wells and that of the surface water behind the dam; pH analyses of well water; and precipitation. Table 1 shows the elevation of water level in the wells and the water behind the dam.

As can be seen, Wells 1 and 4 have been dry since the start of the monitoring program. Wells 2 and 3 are open to the saturated section, and do contain water. Initially, the water levels in the wells were at a lower elevation than the water behind the dam. However, to determine the relationship of the surface water to the ground-water, the dam was breeched on April 14 to lower the elevation of the surface water. Figure 6 is a plot of the water elevations in Wells 2 and 3 and the surface water, along with precipitation data.

Initially the water levels in the wells declined in response to the reduced head in the surface water body. However, the water levels appear to have essentially stabilized at an elevation above the surface-water body. There is a more noticeable response to precipitation since the lowering of the pond level. Sufficient data have not been accumulated to date to ascertain stabilization of the water level or degree of response to precipitation.

Water samples have been collected and pH determinations were made. Table 2 shows the results of these analyses. As can be seen, the pH values from Wells 2 and 3 are quite low indicating that the copperas effluent has permeated the sediments. The initial result shown for Test Well 1 was discussed earlier in the report.

The pH of the water from Well 2 ranged from 2.0 to 2.2. The pH of the water from Well 3 ranged from 2.8 to 3.0. The indications are that a higher percentage of fresh water is contained in Well 3. Precipitation and some surface runoff percolating into the sediments in the vicinity of Well 3 not coming in contact of the copperas is thought to be the principal factor of the differnce in the pH levels. The location of the copperas would have a greater influence which will be reflected by samples from Well 2.

Test Wells 2 and 3 appear to have been installed on either side of what was the original natural stream channel. Figure 7 is an approximate east-west cross section through all four wells showing the relationship of elevations of the wells, along with the profile of the natural ground level in 1930. Mr. John M. McConaghy, Plant Engineer, supplied the cross section as well as the topographic map of the copperas dump area shown as Figure 8.

The source of the contamination is from precipitation falling directly on the copperas pile. Seepage from the pile is evident all along the face of the slope. This highly mineralized seepage discharging from the pile then collects and flows in a stream which eventually ponds behind the dam. Some of the effluent eventually enters the sediments above the dam discharging to the flood plain and river as ground water.

The stockpiling of the copperas in its present location has created an artificial ground-water condition. Normally, the uncon-

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solidated materials are probably not saturated or only saturated in a thin section at the lower elevations. However, with the addition of the copperas, and the nature of this material, precipitation readily infiltrates and slowly percolates downward. A saturated section is established in the lower portion of the pile and the underlying natural sediments.

The thickness of the saturated section varies according to precipitation. The gradient of the water level is a primary factor controlling the rate the effluent is discharge through the sediments. When the gradient is steep, the discharge rate is high, and when the gradient is shallow, the discharge rate is low.

As mentioned earlier, the capacity of the natural sediments to transmit fluid is low, and the transmitting capability of the copperas pile is probably also low. However, the ability to store water can be quite high in both mediums. This will account for the surface flow even after prolonged periods of no precipitation. That is, the sediments and the copperas, act much as a large storage tank which can be readily filled, but leaks out slowly.

Several approaches can be taken to eliminate the source of additional contamination. It is obvious that removal of the copperas from contract with the ground water system, and effectively sealing it from contact with precipitation and surface-water flow would eliminate any contamination. One method of control would be the consolidation of the copperas pile and the covering with an impermeable material with ditching to intercept both precipitation and surface-water runoff before they come in contact with the copperas. The copperas would of course be consolidated above the water table, thus effectively removing the source of contamination from the ground-water regimen.

The pile can be consolidated at its present location, with the piling of the head and toe portion in the center of the mass. The pile must then be prepared for covering. To insure the effectiveness of the cover, the existing observation wells should be left in place, and additional ones installed around the down gradient sides close to the pile.

If it is found that the cover is ineffective in diverting direct precipitation from coming in contact with the copperas, the possibility of retaining both surface water and ground water effluent can be accomplished by means of a dam. However, it must be pointed out that since a portion of the copperas is saturated, a considerable amount of time must elapse before the fluid will drain out after the cover has been emplaced. Therefore, any monitoring wells will necessarily reflect this effluent drainage for some time.

Another alternative, and in our opinion the best choice at present to eliminate the source of the contaminant, is to remove the pile from its present location to a site which would adequately protect the environ from any effluent. Such a site exists at the

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large tailings-pond south of the quarry.

As mentioned in our letter report of November 1971, this site was suggested as a repository for not only the copperas, but also the solids from the acid sludge holding pond. This report was submitted shortly after a field investigation was conducted at the plant site. At that time it was noted that the material in this tailings pond and that of the natural land surface was predominantly clay.

Some site preparation would be necessary prior to the relocation of the solids. Some of the existing material should be excavated and the waste solids compacted at this site. To assist in altering the pH of any effluent draining from the pile, limestone can be mixed with the disposed wastes.

The choice of this site to dispose of the wastes was selected for several reasons. The clayey nature of the material was of course an important factor but also the hydrologic setting was a primary consideration. It is felt that the consolidation of wastes and the covering with the native soils would reduce the volume of precipitation from coming in contact with the solids and also remove these solids from the ground-water regimen. Drainage of any effluent from this site would be very slow. It is felt that the volume and rate of movement of any effluent would be insignificant.

Ideally, the site should be graded so that all runoff from precipitation will be carried away from the buried copperas. The covering clay should be a few feet thick, rolled and graded so that no ponding of precipitation or surface runoff should take place directly above the buried copperas.

Ditching around the periphery of the pile, if necessary, should be installed to lead any surface runoff from the surrounding land away from the buried copperas. In other words, the physical setting should be designed to reduce the volume of water that may come in contact with the copperas. The surface may be domed or a steep graded flat surface or any shape conducive to suit the above requirements.

As mentioned previously, even after the source of the contaminant has been removed from the present storage site, the effluent presently in the sediments will take some time to flush. In an effort to better define the volume and time elements of the copperas effluent, some computations have been made based on known and inferred data.

A rough estimate of the volume of saturated sediments under the copperas has been computed from the topographic map. It is assumed that the stream level running from the copperas is the top of the saturated thickness, and the top of the bedrock which is projected, the base. The total volume of saturated unconsolidated sediments is on the order of 3.5 million cubic feet.

If we assign a specific yield of 10 percent to the natural sediments, we will obtain a measure of the water yielding and storing capacity. This percentage is a reasonable one based on field inspection of the material. The effective volume of effluent we are now dealing with is then 350,000 cubic feet. A cubic foot contains 7.48 gallons, therefore, the volume of effluent presently in the sediments is approximately 2.6 million gallons.

This is only the volume of effluent contained in the sediments up to the dam, since it is felt that it is these sediments that are the controlling factor in rates of movement. The river flood plain is considerably more permeable and has higher transmissivity characteristics. This is based on field observation rather than actual testing of the sediments. Therefore, the volume of effluent reaching the river can only be as much as that amount which can pass through the less permeable sediments plus surface flow.

Assuming the surface flow is eliminated, then the rate of drainage through the sediments is the controlling factor in determining the elapsed time for flushing the effluent. The average transmissivity obtained is 300 gpd/ft from these sediments. The average width of the saturated section at the dam is estimated to be 400 feet, and the hydraulic gradient is about 0.004 feet per foot. Therefore, the volume of effluent reaching the river flood plain is about 500 gallons per day. On this basis, the total time required to drain the sediments of effluent is estimated to be about 5,200 days or approximately 14 years. However, the initial drainage would be at a much higher rate, probably reducing the time element by one-half or about 7 years.

If the copperas is removed from its present site to the tailings-pond, there is no way to predict the total effect on the ground-water flow and rates of movement, since a portion of the copperas pile is saturated. Therefore, to better define rates of movement, and refine the time required to flush the sediments, a series of small diameter borings and wells should be installed in the natural sediments. Approximately six wells, carefully levelled in should provide the data required for this refinement. If at all possible, the existing Test Wells 2 and 3 should be left in place. However, if the locations of the wells interfere with the removal operations, an attempt should be made to salvage the casings and screens.

The new test wells should be installed after the removal operations have been completed. That is, once the copperas is removed and the natural sediments have been exposed and stabilized, the wells can be installed. This data obtained from these wells will reflect the readjustment of water levels to the new conditions, along with the establishment of a gradient.

This report has dealt primarily with the copperas waste pile, however, other acid wastes solids are stockpiled on the property. These stockpiles should be assessed and disposed of if necessary in the same manner as the copperas. That is, mixed with limestone placed in the tailings-pond and covered.

In an attempt to maintain the pH of the river at an acceptable level during drainage of the effluent from the sediments, a limestone solution can be fed into the stream. In addition, limestone can be placed in and around the vicinity of waste stockpiling and harrowed into the soil. Limestone can be added to the several small streams and ponds that may have unacceptable pH values and low velocities. Finally, the abandoned acid sludge holding pond can be lined with limestone.

The above mentioned plans are attempts to maintain the river water at an acceptable pH value until the sediments are flushed of acid. As can be seen considerable time must elapse before complete flushing takes place. Because of the nature of the sediments and the sources of contamination, there appears to be no practical or economically feasible way to hasten the removal of the effluent. Once the source of contamination has been removed, the draining and flushing of effluent will start.

Respectfully submitted,

GERAGHTY & MILLER, INC.

May 17, 1972

Frank A. DeLuca

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Table 1 - Elevation of water in test wells and pond, American Cyanamid Company Plant Site, Piney River, Virginia.

Date of Sample	Time	Elevation of water in Well No. 1	2	3	4	Elevation of Water in Pond
3- 8-72	-	Dry	894.92	894.57	-	-
3- 9-72	-	do	894.58	894.6	Dry	-
3-10-72	-	do	894.58	895.0	do	-
3-13-72	-	do	894.75	894.5	do	-
3-15-72	1,445	do	894.75	894.54	do	895.460
3-21-72	1,050	do	894.75	894.58	do	895.792
3-21-72	1,300	do	894.75	894.625	do	895.834
3-22-72	1,245	do	894.83	894.75	do	895.250
3-23-72	1,315	do	894.83	894.583	do	895.22
3-24-72	1,500	do	894.705	894.5	do	895.25
3-27-72	1,430	do	894.663	894.5	do	895.25
3-28-72	1,400	do	894.663	894.417	do	895.167
3-29-72	1,330	do	894.663	894.417	do	895.167
3-30-72	1,300	do	894.58	894.417	do	895.167
3-31-72	1,315	do	894.622	894.458	do	895.167
4- 4-72	1,500	do	894.622	894.4375	do	895.167
4- 5-72	1,300	do	894.538	894.292	do	895.167
4- 6-72	1,430	do	894.622	894.375	do	895.000
4- 7-72	1,300	do	894.663	894.417	do	895.000
4-10-72	1,300	do	894.58	894.417	do	895.000
4-11-72	1,400	do	894.622	894.417	do	895.000
4-12-72	1,500	do	894.622	894.417	do	895.000
4-13-72	1,400	do	894.663	894.500	do	895.000
4-14-72	1,530	do	894.330	894.167	do	892.900
4-17-72	1,300	do	894.247	893.917	do	891.900
4-18-72	1,515	do	894.167	893.917	do	891.900
4-19-72	1,300	do	894.167	893.833	do	891.900
4-20-72	1,430	do	894.080	893.875	do	891.900
4-21-72	1,330	do	893.955	893.750	do	891.900
4-24-72	1,500	do	894.163	893.792	do	891.900
4-25-72	1,500	do	894.163	893.750	do	891.900
4-26-72	1,300	do	894.105	893.625	do	891.900
4-27-72	1,515	do	894.163	893.583	do	891.900
4-28-72	1,400	do	893.955	893.542	do	891.900
5- 1-72	1,400	do	893.913	893.542	do	891.900
5- 2-72	1,345	do	893.913	893.542	do	891.900
5- 3-72	1,430	do	893.997	893.667	do	891.900

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Table 2 - pH values of samples obtained from the test wells, American Cyanamid Company Plant Site, Piney River, Virginia.

Date of Sample	Well 1	Well 2	Well 3	Well 4
3- 2-72	3.8	-	-	-
3- 8-72	Dry	-	-	Dry
3-15-72	do	2.1	2.8	do
3-22-72	do	2.1	2.8	do
3-29-72	do	2.1	3.0	do
4- 5-72	do	2.0	3.0	do
4-12-72	do	2.1	3.0	do
4-19-72	do	2.0	2.8	do
4-21-72	do	2.2	3.0	do
4-26-72	do	2.1	2.8	do
5- 3-72	do	2.0	2.8	do

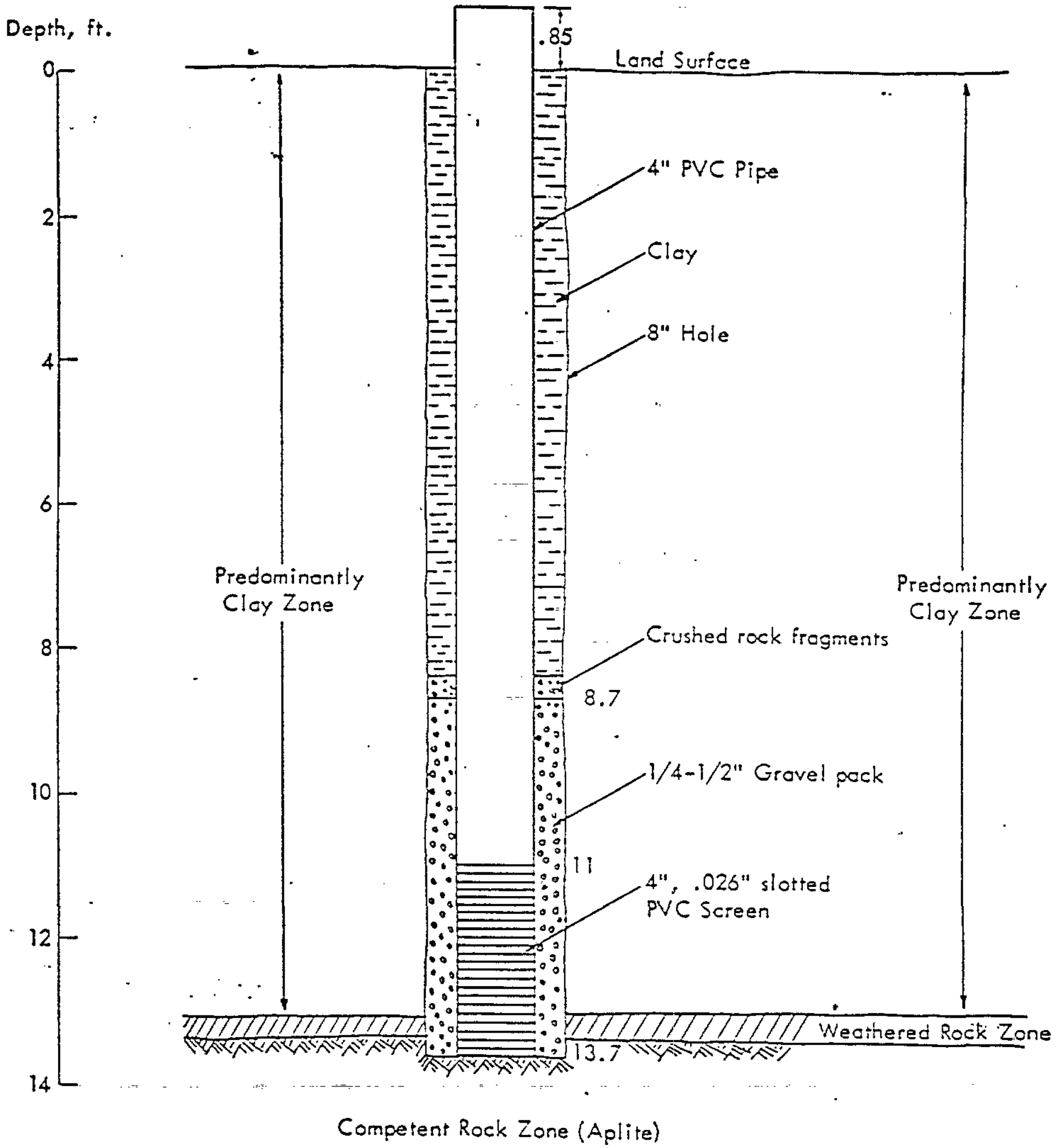

FIGURE 2

WELL CONSTRUCTION DETAI
OF TEST WELL 1

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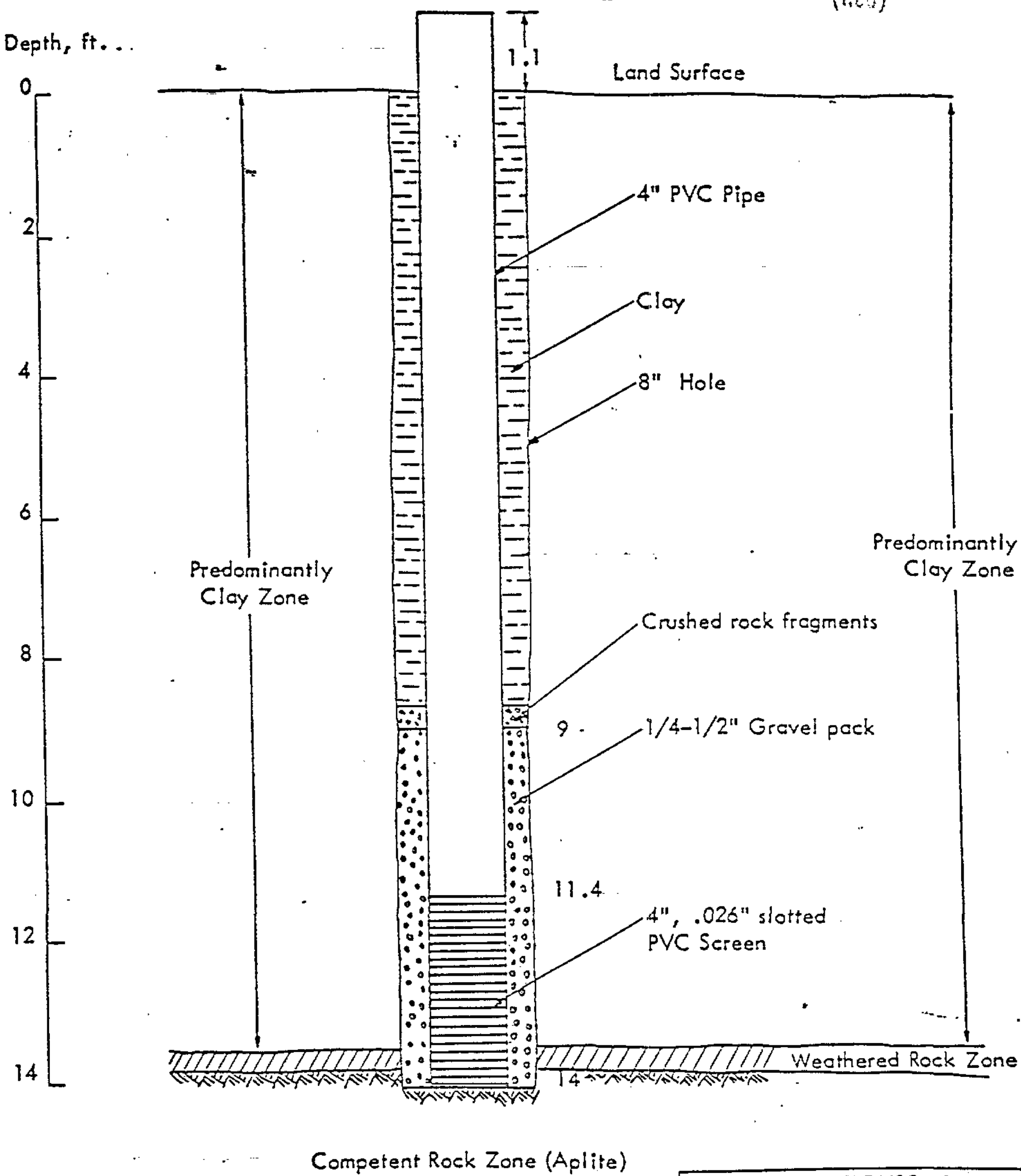

FIGURE 3

WELL CONSTRUCTION DETAI[L]
OF TEST WELL 2

AMERICAN CYANAMID COMPA[NY]

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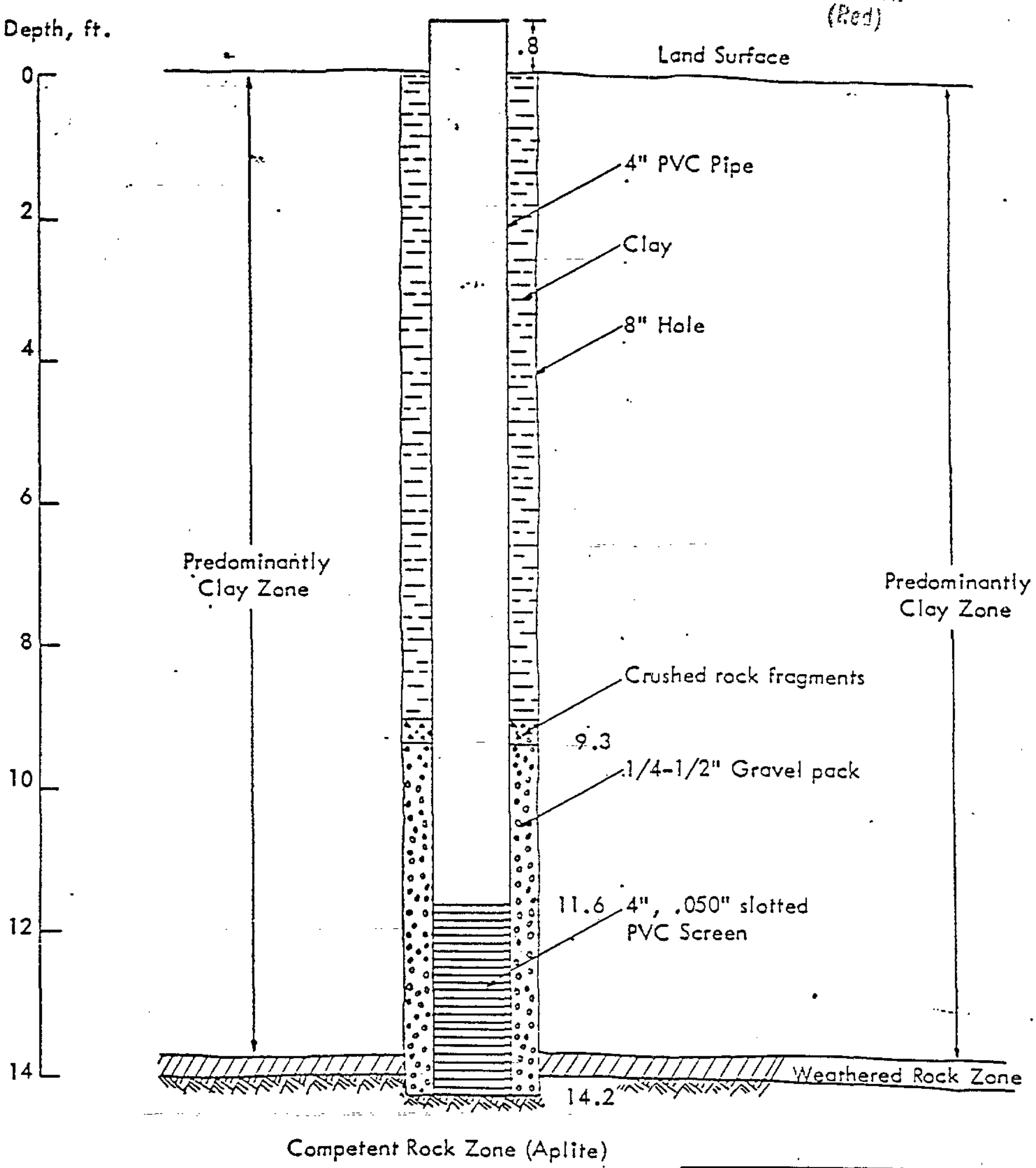

FIGURE 4

WELL CONSTRUCTION DETAIL OF TEST WELL 3

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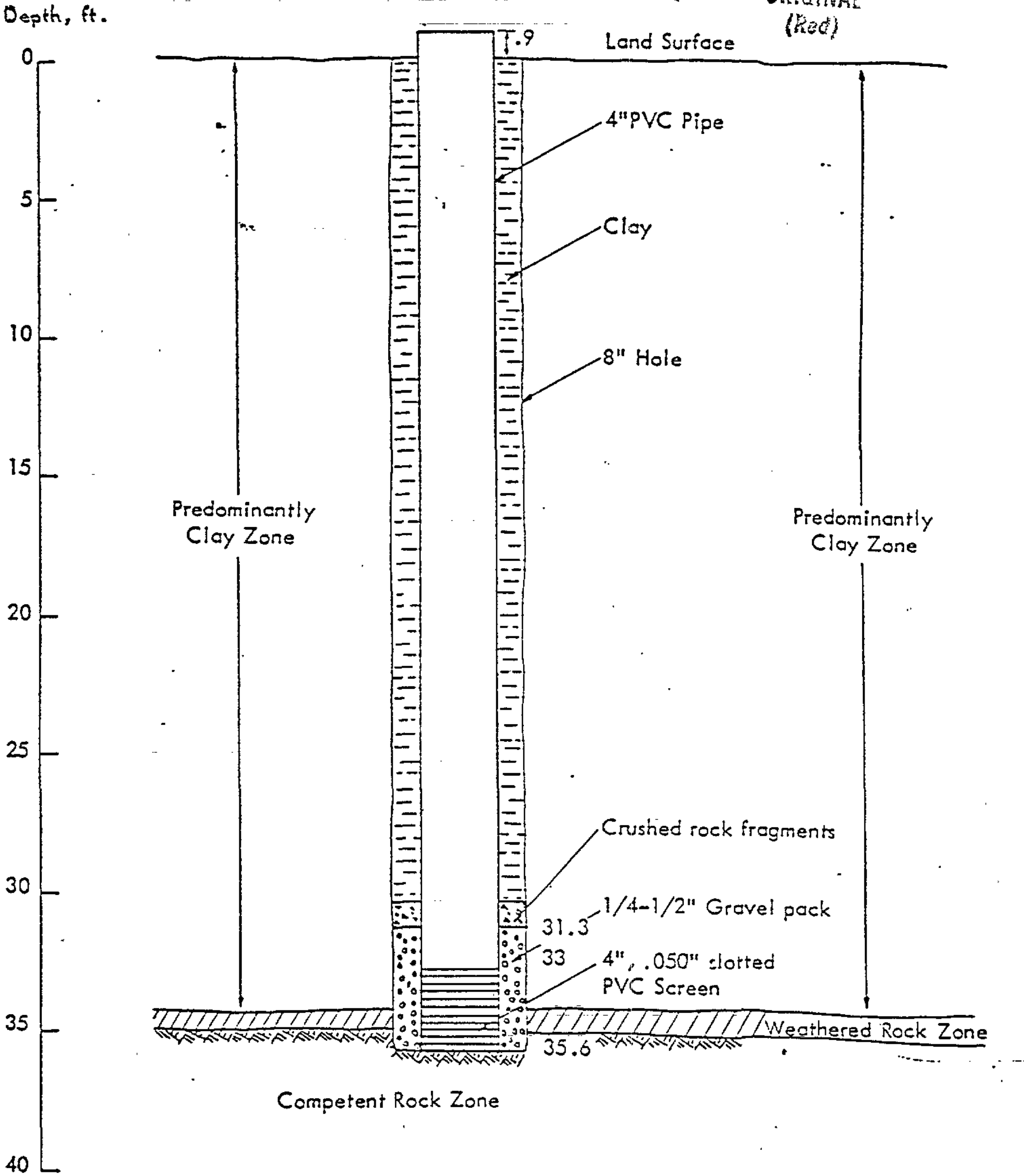

FIGURE 5

WELL CONSTRUCTION DETAIL OF TEST WELL 4

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PINEY RIVER VIRGINIA

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